papago: A Machine Translation Service with Word Sense Disambiguation and Currency Conversion

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Abstract

In this paper, we introduce *papago* - a translator for mobile device which is equipped with new features that can provide convenience for users. The first feature is word sense disambiguation based on user feedback. By using the feature, users can select one among multiple meanings of a homograph and obtain the corrected translation with the user-selected sense. The second feature is the instant currency conversion of money expressions contained in a translation result with current exchange rate. Users can be quickly and precisely provided the amount of money converted as local currency when they travel abroad.

1 Introduction

papago[1] is a multi-language machine translator for mobile device that supports English, Japanese, Chinese and Korean. The mobile application is similar to Google Translate, Microsoft Translator and Baidu Translate.

With the spread of smartphones and increasing of overseas trips, the need of the translation service for mobile devices is increasing. As artificial intelligence technology develops, there are growing expectations of a translator among users.

Most translators take voice, text or images as an input, display the translated text and output the sound converted the text into speech. Therefore, the translation service requires use of high-level technologies including speech recognition, optical character recognition, machine translation and speech synthesis. *papago* can take voice, text or image as an input and provide both translation text and text-to-speech as outputs in common with other translators.

In addition, we introduce new features that can provide convenience for users as follows:

- **Word sense disambiguation (WSD) based on user feedback**: The translator suggests multiple meanings of a homograph in an input sentence. Users can select one meaning and obtain the re-translated sentence with the user-specified sense. Each sense is given as a simple picture within the translation result screen.

- **Instant currecy conversion**: If there is a money expression in an input sentence, our translator provides the instant currency conversion of money expressions with current exchange rate. Users can quickly and precisely be provided the amount of money converted as local currency during their traveling abroad.

In this paper, we focus on two features briefly described above. Section 2 explains the word sense disambiguation based on user feedback. Section 3 presents the instant currency conversion and the money information extraction. In section 4, we conclude the paper.

[1] https://play.google.com/store/apps/details?id=com.naver.labs.translator

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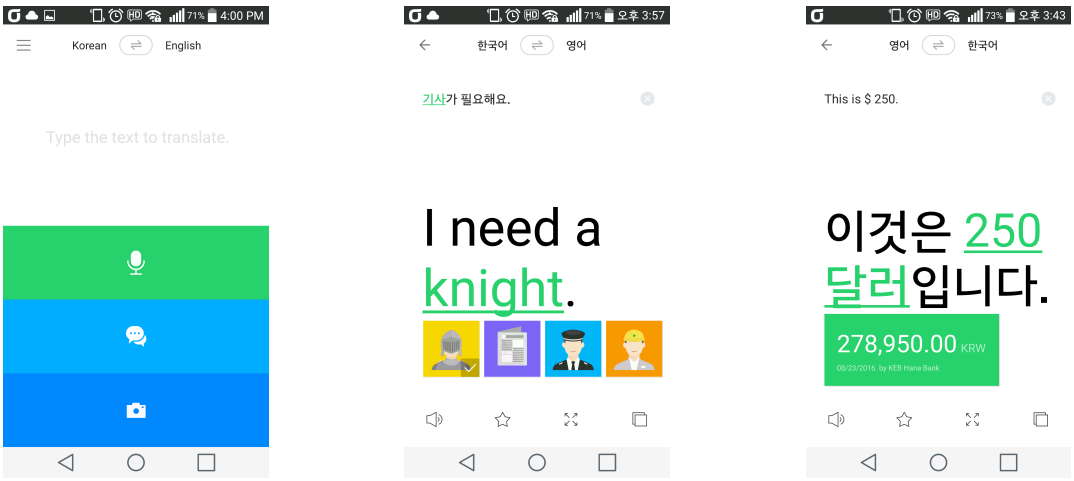

(a) Beginning screen (b) WSD (c) Currency conversion

Figure 1: Screenshots of *papago*

2 Word sense disambiguation based on user feedback

The first proposed feature, WSD[2] is needed by the following reasons:

- In mobile devices, translator users tend to input short and ambiguous sentences. If the input includes a homograph, it causes a lack of the word context and so its translation result can be different from user intention. For example, In Korean-to-English, the input '기사가 필요해요', whose meaning is 'I need 기사', has a homograph '기사' which has four senses, a knight, an article, a driver and an engineer. A translator cannot understand user intention, i.e. the precise meaning of '기사'.
- Users may want to correct only several words of an incorrect translation result.
- Users may want to verify if the translation of a homograph is correct or not.

To satisfy such demands, we propose the feature that helps users inspect which sense a homograph translation has, and change it to another translation. We also propose to use pictures when suggesting multiple meanings of a homograph to users. Picture is a great means to suggest word meanings to users, because users can easily understand word senses through pictures and they are applicable regardless of language. If user selects a picture, the application shows a new translation result. Figure 1b shows user interface for suggestions of WSD.

To implement this feature, we have to solve two technical problems:

1. Detecting a homograph and its translation from the input and output sentence pair.
2. Re-translating the input with user-selected sense, i.e. corresponding translation with the selected picture.

2.1 Detecting homograph and its translation

We detect both a homograph in an input (source sentence) and the translation of the homograph in the output (target sentence), based on dictionary-based matching after the translation decoding process. We determine whether each word contained in both source and target sentences is highlighted or not. We use the phrase alignment links acquired in the decoding process to recognize the connection between the homograph and its translation word to be highlighted. We can obtain the phrase alignment after decoding of each sentence, because our translator employs the (hierarchical) phrase-based(Koehn et al., 2003; Chiang, 2005) model as a core translation model.

[2]In natural language processing field, WSD generally refers to the task in which researchers determine a sense for each ambiguous word in a given sentence, fully automatically. We call the feature WSD, even if we manually disambiguate a word sense by users.

Korean	English	Chinese	Japanese	Picture
기사	article	记事	記事	기사_article.png
	knight	骑士	騎士	기사_knight.png
	driver	司机	運転手	기사_driver.png
	engineer	工程师	技師	기사_engineer.png

Table 1: Example of dictionary for WSD

We look a word up in the dictionary for WSD. It is a manually constructed list of pairs of a homograph and its translation for three language pairs: Korean-English, Korean-Chinese and Korean-Japanese. Therefore, we only support three directions for WSD. Table 1 shows a part of the dictionary for WSD.

Korean nouns were selected from the Standard Korean Language Dictionary of the National Institute of the Korean Language (NIKL)[3]. The dictionary was constructed through the following process:

1. Korean nouns with two or more senses are selected as entry candidates.
2. For each sense of each candidate, we find English, Chinese, and Japanese translations from a translation dictionary.
3. Save the word and its translations, if all translations of each sense are found, exclude it, otherwise.
4. Make a picture suitable for each sense and save it in the database.

We have finally acquired 931 Korean homographs and 2,050 translations of them for each target language: English, Chinese and Japanese[4]. We have constructed the entry with top-N frequent nouns of our corpus, so that it can cover as many homographs as possible.

2.2 Re-translating with user-selected sense

Our desired re-translation method is not a primitive word replacement but re-decoding a whole sentence. For example, if a user selects 'car' rather than 'tea' (picture) in the translation 'A cup of tea, please' of '차 좀 주세요', the translation should be corrected to 'Give me a car.' Thus, we propose a modified (hierarchical) phrase-based decoding method for re-translation.

If user selects a picture, i.e. a word sense, its corresponding translation, which can be a single or multi-word, is delivered to the translation decoder. For the reliable re-translation, we implemented online phrase filtering method for SMT decoder. SMT decoder recognizes the user request as (a list of) a source word index and its corresponding target word. When the decoder translates the source phrase containing the user-specified source index, it ignores every phrase pair whose target phrase does not contain the user-specified target word. Sometimes it is possible that there is no suitable phrase pair at all. In this case, we treat the specified source word as unknown word and replace it by the target word at post-processing. This guarantees the occurrence of the target word in translation result.

3 Instant currency conversion

International travelers commonly have needs of currency conversion. It may be useful for travelers to provide the currency-converted price in addition to translation result.

We propose the second feature that instantly converts the currency of the price contained in a money expression. If a translation result contains an expression of money, our translator highlights it and shows the price converted with the current exchange rate. The screenshot of this feature is shown in figure 1c. It is processed through the following process:

1. Translate the input sentence into target language.

[3] http://stdweb2.korean.go.kr/main.jsp

[4] Since the submission we have expanded the entry of our homograph list. We had acquired 455 homographs and 1,024 translations when we submitted this paper.

2. Detect and normalize money expressions from the translation result. (Described in section 3.1)

3. If one or more money expressions are detected, make an inquiry about current exchange rate[5].

4. Convert the amount of money obtained in 2. into the target currency.

Our policies for dectection and conversion of money expressions are as follows: We detect only currencies corresponding with source and target laguages of a translation result; e.g. US dollar and Korean won for English-to-Korean translation. And also, we convert the normailized value into the currency of opposite nation; e.g. Korean won to US dollar or US dollar to Korean won for English-to-Korean translation.

3.1 Detecting and normalizing money expression

We develop a module of money information extraction for the four languages: Korean, English, Chinese, and Japanese. It takes a raw sentence as an input, and generates a set of MONEY tags as an output. The MONEY tags convey some meta information about the money expressions. For the sentence "We borrowed 10 dollars from him", there will be one MONEY tag whose extent is '10 dollars'. The tag will also have a normalized amount of money (e.g., 10) and the corresponding currency (e.g., USD), where the format of currency follows ISO 4217[6]. The task of normalization of money expression is difficult due to the various ways of representing the same amount of money. For instance, the money expressions 'three dollars' and '3 bucks' mean the same amount of money. Moreover, some variations of money expressions are language-specific. The amount of money can be a real number in English, while it is not the case in some other languages (e.g., Korean). By taking these linguistic variations into account, the rules are carefully designed. To evaluate the rules, we construct the MONEY tagged corpus that consists of 300 - 500 sentences for each language. The evaluation results with the dataset show F1-scores higher than 94 in every language.

4 Conclusion

We introduced a machine translation service which is equipped with new features that can provide convenience for users. By using WSD based on user feedback, users can select one among word senses and obtain the corrected translation with the user-specified meaning. By using instant currency conversion, users can be quickly and precisely provided the amount of money converted as local currency when they travel abroad.

For the future work, we plan to also support English-to-X not only Korean-to-X for WSD. Moreover we try to design the database and the system architecture that can recognize multiple translations, i.e. synonyms for each sense in the dictionary for WSD.

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[5]We use the three exchange rates, Korean won per US dollar, Korean won per Chinese yuan and Korean won per Japanese yen. They are provided by KEB Hana Bank every hour. We can obtain the rates for all of 12 conversion directions between 4 languages from combinations of the three rates.

[6]http://www.iso.org/iso/home/standards/currency_codes.htm